UNIVERSITY OF CALIFORNIA
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THE CONTROL OF WILD MORNING GLORY

BY CLYDE C. BARNUM

Typical Morning Glory Vine.

CONTENTS

DIRECTOR'S NOTE

This circular has been prepared in response to numerous inquiries received by the Agricultural Experiment Station and the State Department of Agriculture at Sacramento regarding Morning Glory control. The recommendations are not very encouraging but are the best that can be made at present. The clean culture method described, although expensive, is ultimately effective and has proved economical. The use of sprays for weed control in the fog belt requires for successful results the services of a well-informed worker.

INTRODUCTION

The term "Morning Glory" is applied to a certain weed found throughout the cultivated lands of almost every rural community in the state of California. It forms twining green mats and owes its common name to its white flowers which open early in the morning. (See frontispiece.) Different names are applied in various places to this weed, such as Orchard Morning Glory, Field Morning Glory, Field Bindweed, European Bindweed, and Cornbind. All these names apply to a single species, an introduced weed, which came to America from Europe and spread from the Atlantic seaboard to the Pacific Coast. The botanical name of the plant is *Convolvulus arvensis.*

Wild morning glory is a perennial; that is, it lives through the year, and is annually renewed by means of a very extensive root system of succulent underground stems and fibrous roots, which may penetrate to depths of six to ten or more feet according to the soil formation. (See fig. 1.) It usually gains a start in cultivated fields from seeds sown in carelessly screened seed grain or scattered in fresh barnyard manure which had not been composted enough to heat, germinate, and kill them. Bean or grain straw used as mulch also often carries the seed. Small patches of morning glory often arise from seedlings or small fragments of roots. These should be eradicated and they can be if care is taken to dig them out thoroughly during the first year. Morning glory seed is described[11] as follows: "A dark brown oval seed with a convex face, the opposite side ridged with a broad ridge. Seeds measure approximately one-sixth of an inch in length, the surface is roughened and somewhat dull." (See

fig. 2.) The plant often increases the area covered by sending out lateral roots from its main root which in turn send up sprouts to the surface and more roots leading down to moisture and food supplies underground. (See fig. 3.) The plants thus grow in an annually

Fig. 1.—Vines and part of root of wild morning glory showing great depth of penetration of roots.

increasing circle. At the same time, in the regular course of plowing and cultivation many of the lateral roots are torn loose and carried long distances. In every case where these root-branches are embedded in the moist soil under favorable conditions, they establish themselves and form other colonies, where the process is repeated.

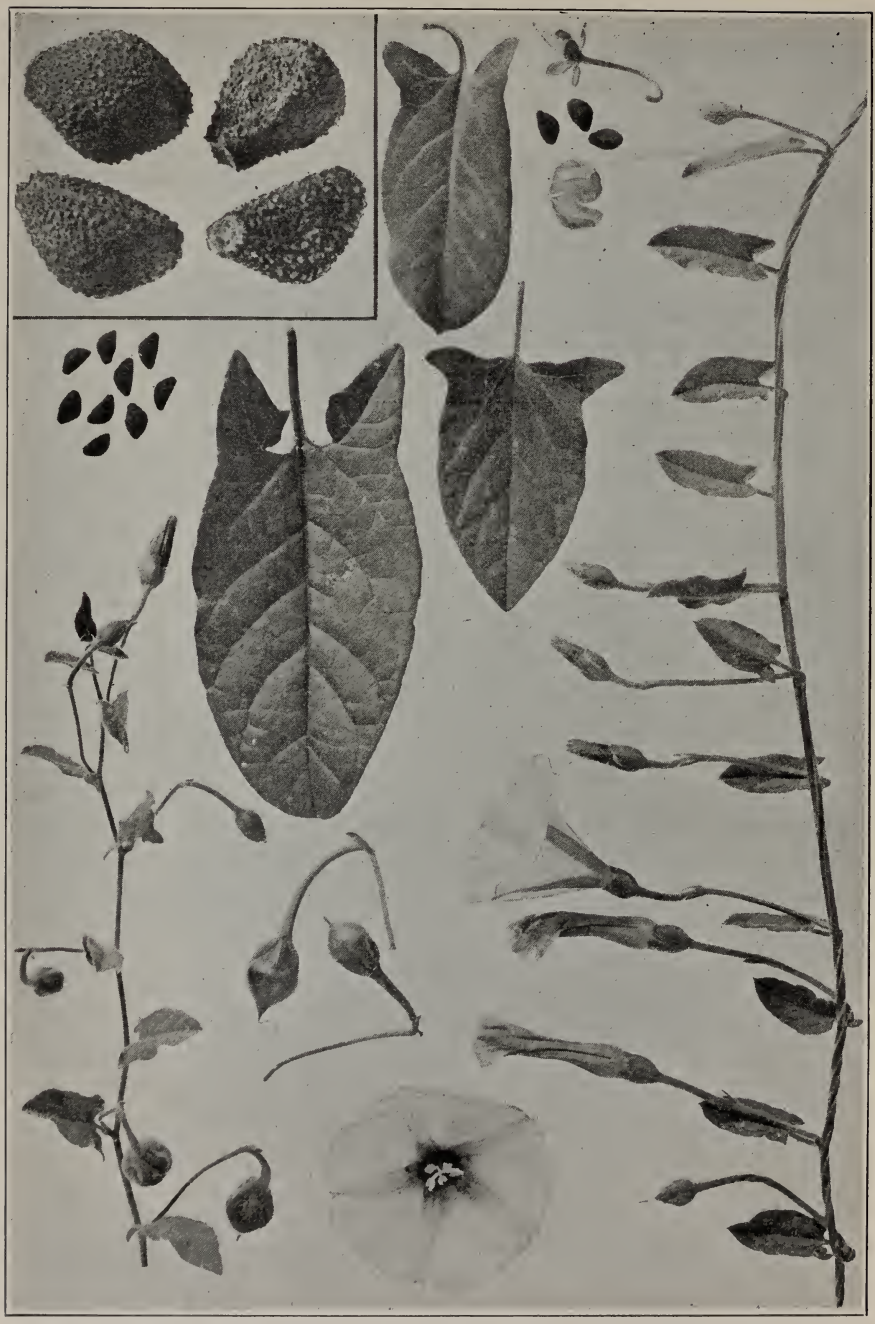

Fig. 2.—Leaves, flower buds, open flowers, mature seed capsules and seeds of wild morning glory (natural size). Insert: wild morning glory seeds magnified five times.

DISTRIBUTION

Morning glory is the most serious weed pest in the state of California today and is found, according to a survey made by the United States Department of Agriculture in 1921 through the coöperation of the farm advisors, in the following counties: Humboldt, Mendocino, Sonoma, Marin, Napa, Solano, Yolo, Sutter, Butte, Tehama, Shasta, Yuba, Placer, Sacramento, Contra Costa, Alameda, San Joaquin, Stanislaus, Merced, Madera, Santa Cruz, Monterey, San

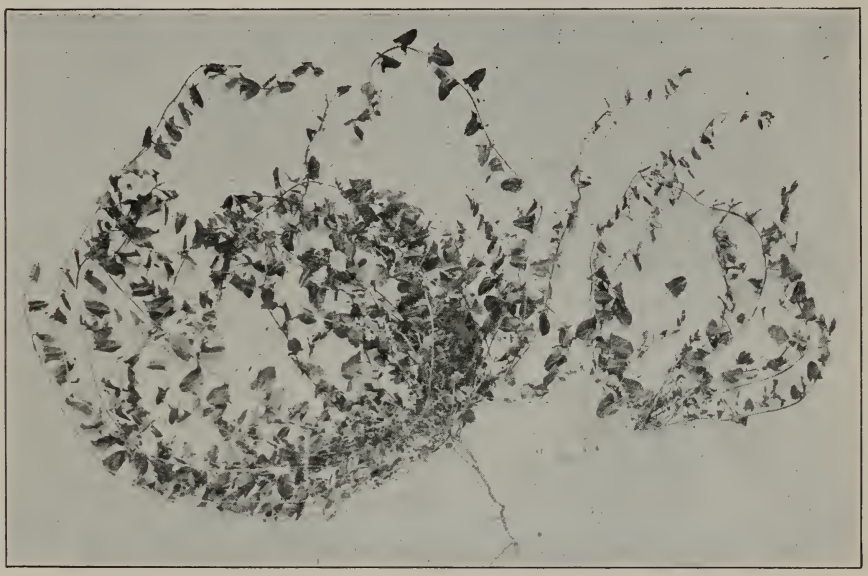

Fig. 3.—Morning glory plant showing part of root system and method of spreading by underground branches.

Luis Obispo, Santa Barbara, Ventura, Los Angeles, Orange, San Bernardino, Riverside, and San Diego. The weed is found in many other counties as well where, however, it is of less economic importance. This widespread distribution, following the path of extensive agricultural development in the richest soils of the state, shows very plainly the serious menace of this weed to our agriculture. (See figs. 4 and 5.) In California thousands of acres of otherwise fertile soil are abandoned to morning glory, and throughout the United States many times as many acres yield little or no crops because of it. It is the duty of every agriculturist to help check this menace to agriculture. This weed *can* be controlled under certain conditions; it

therefore seems advisable to publish this circular to explain the best known methods of attacking the problem of control. They are methods recommended by investigators in all parts of the world, and some of them may be applicable to conditions in California.

PLANT PHYSIOLOGY IN RELATION TO CONTROL

The farmer who would try to rid his land of morning glory should bear in mind a few helpful facts regarding plant nutrition and physiology. Plants manufacture, by means of sunlight and the green coloring matter (chlorophyll) in their leaves and stems, simple

Fig. 4.—Tomato field badly infested with wild morning glory.

sugars which are soon changed to starch by chemical action and stored in the leaves during the day. (In this manufacturing process the plant absorbs carbon dioxide gas from the atmosphere, and by some chemical change, little understood, combines this gas with water in the living cells to form these simple sugars. Sugars are soluble and can be transported in a liquid form through the plant system from cell to cell, while starch, as such, is insoluble and cannot be thus transported.) During the hours of darkness the insoluble starch manufactured during the previous day is changed back to sugar and carried down to the roots where it is utilized for new root growth and cell structure, or again changed and stored as starch. It is by this process that the plant grows, with the support of a good root system

and good soil, if a water supply be available. Any mechanical or chemical interference with any one portion of the plant tends to decrease its vitality. As the season advances, the morning glory plants continue to send the elaborated plant foods or sugars to be transformed and stored in their roots, and these roots gradually become richly charged with starch. Although frosts come and kill the tops, the roots remain alive throughout the winter, and await only the coming of warm weather for renewing their activity.

Fig. 5.—Small areas of morning glory such as this should be kept below ground. Seeds from this colony are easily spread to the clean soil.

Spring weather brings up new shoots which grow rapidly by using the large quantities of stored plant food remaining in the roots from the past summer. The amount of this stored food is so large that cutting the tops off from time to time has little effect on the plant, which sprouts repeatedly after successive cuttings with apparently undiminished vigor, especially if it has made any considerable growth of leaves in the intervals between cuttings. During these intervals the plant restores the starch content in a very few days. Any method which tends to deplete the stored up food supplies, without permitting the plants to recuperate, hastens the end of the plant's growth.

These facts will aid the farmer to choose the method of eradication best suited to his case.

"CUTTING" AS A MEANS OF CONTROL

The method of control that is recommended by nearly all investigators is that of systematic, thorough "cultivation," by which they mean the cutting of the plants below the surface of the soil with horizontal blades. (See fig. 6.) This method is here referred to as "cutting." All the investigations have proved its efficacy and established the fact that proper procedure along these lines will eradicate

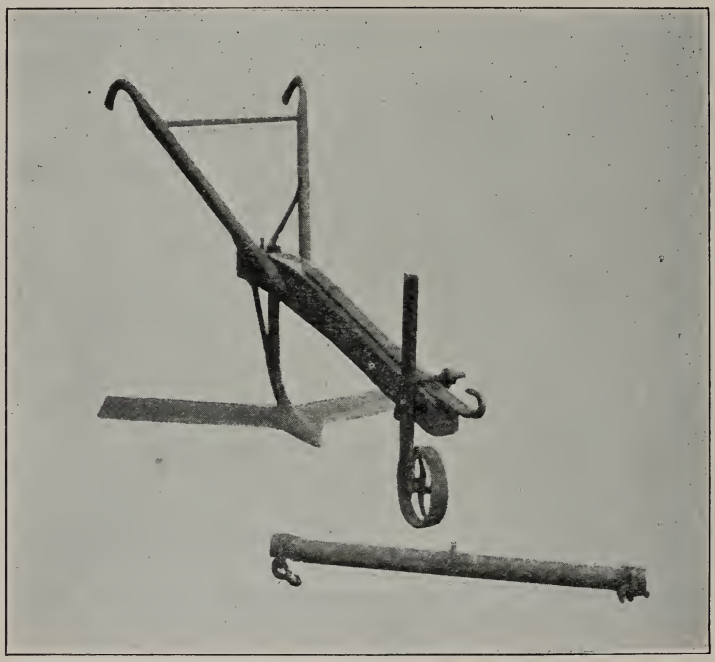

Fig. 6.—One-horse weed knife, made by blacksmith, used in tomato culture.

the pest. Adequate implements can be purchased or made in local blacksmith shops. (See figs. 7 and 8.)

Frederic T. Bioletti carried on extensive investigations at the University Farm at Davis in the summer of 1910 and reported his findings in a circular issued by this Station now out of print.[4] He found that ordinary orchard cultivation was not sufficient to control the weed. He further showed that, if a field of ten acres was thoroughly covered every five days during the growing season by a weed knife, 4½ feet long and 4 inches wide, drawn by a team, practically no living plants would be left in the field to reappear the following year. (See fig. 7.) The morning glory was not allowed to appear above the

surface at any time during the course of the experiment. In this way he succeeded in killing 99.95 per cent of all the morning glory in the first three feet of soil. This work was done on a good type of deep soil where the weed flourished in spite of ordinary culture. The field is now planted in grapes and is easily kept clean of weed growth. The results were not so successful when the interval between the cuttings was seven days.

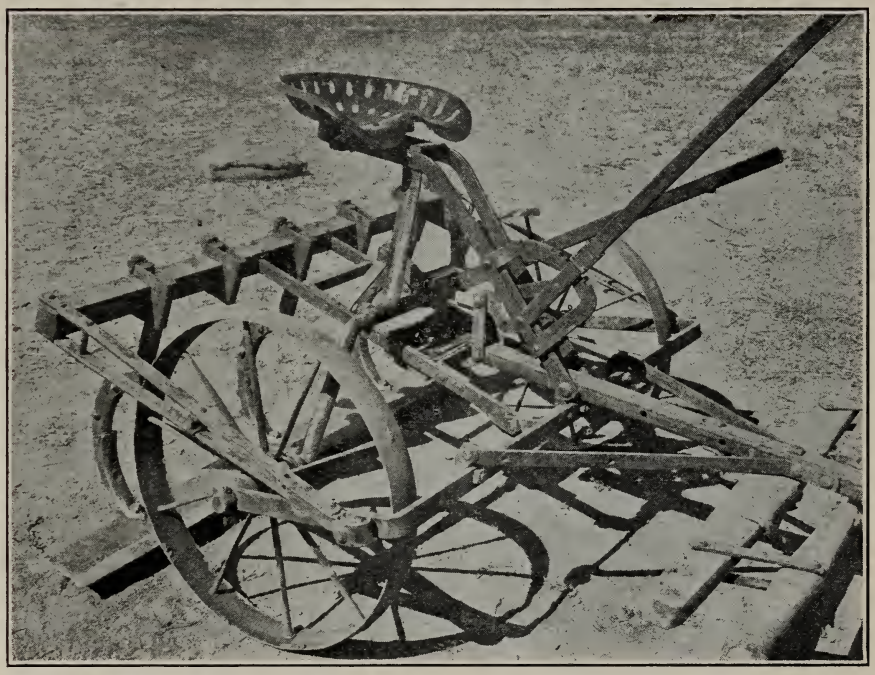

Fig. 7.—Two-horse weeder used for morning glory control. The blade can be raised from the seat.

Investigations of clean culture methods carried on by the Spreckels Sugar Company[1] at Spreckels and elsewhere indicate that this method of control is satisfactory when the cuttings are frequent enough to prevent the appearance of green leaves. It was found that the interval of five days between cuttings was the longest that could be allowed.

During the year 1915–16 some work was done at Davis by Thomas Tavernetti on the control of the morning glory by cultural means, in conjunction with the work done by George P. Gray in the study of chemical methods of control. Tavernetti found that the method of plowing by which the field was plowed to a depth of eight inches

every two weeks during the period beginning February 15, 1915, and closing October 27, 1916, was expensive and unsatisfactory. It was difficult to keep the plowshares sharpened and consequently many roots were not cut. The intervals between the plowings were too long, and green plants appeared from time to time. As a result the plants recuperated many times during the summer and were not seriously weakened. The rough plowed land dried out rapidly and the roots used little of their reserves. Plants in well cultivated soil where a weeder was run every five days during the growing season

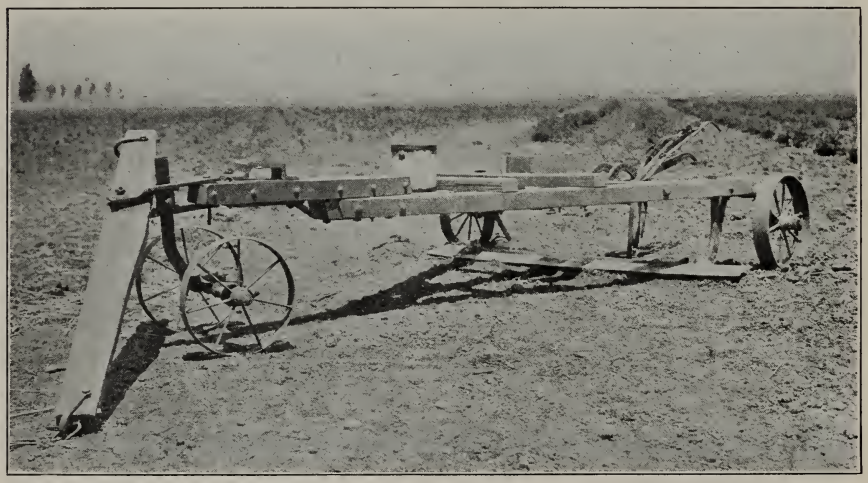

Fig. 8.—Three-horse weeder, made by blacksmith, used for morning glory control. For heavy soils a shank should be placed at center.

used their reserves much more. The Alameda Sugar Company at Alvarado, Alameda County, California, has imported a cutting machine which cuts the morning glory roots eighteen inches below the surface of the soil, thereby enabling the growers to develop a crop of beets before the morning glory recovers sufficiently to injure them. (See fig. 9.)

The work done at Davis on weed-cutting makes possible the following recommendations:

1. "Cutting" should be more frequent in the spring and early summer than in the late summer and fall.
2. The land should not be allowed to dry out during the summer.
3. The "cutting" should be deep. (See fig. 10.)

After studying the work of the investigators, it appears that eradication by clean culture can best be done as follows:

1. Plow deep (8 to 10 inches) early in the season before the spring growth of morning glory has appeared. Work the soil into as good condition as possible. Do not work the soil when wet.
2. Provide a substantial weeder—horse or tractor drawn, accordind to the size of the infested area and farm conditions—and use it every five days after the first morning glory sprouts appear.

Fig. 9.—A very efficient type of weeder and sub-soiler, drawn by 80 h.p. Holt tractor and running 16 to 18 inches deep. With this machine it is possible to grow sugar beets without hindrance from morning glory. The implement is made at Liverpool, England.

3. Run the weeder as deep as it can be drawn (4 to 6 inches at least); since, the deeper the cutting, the less likelihood is there that the plants will reach the light before the next cutting.
4. After irrigation, cultivate as soon as the soil is dry enough in order to prevent the appearance of green leaves.
5. *Do not allow the plants to reach the surface at any time during the summer. Unless the work is done thoroughly it is wasted.*

The clean culture method is dependent on non-recuperation of the plant. Gradual depletion of the food stored in the root systems is therefore brought about by the continued removal of all sprouts,

since these draw on this stored up food as long as they are below ground. Continual cultivation will tend to maintain moisture in the soil, thus encouraging plant growth and forcing depletion of the stored up food in the roots. The frequent use of a weeder will form a hard plow sole below the surface mulch. This sole should be broken up before the heavy rains come in order to permit the water to penetrate. A little care taken the following summer to dig out any stray plants of morning glory will remove all traces of the pest.

Fig. 10.—The Alameda Sugar Company at Alvarado, California, use this weeder, drawn by 80 h.p. Holt tractor, in preparation of morning glory infested beet land. It runs 10 to 12 inches deep.

ALFALFA AS A SMOTHER CROP

The term "Smother Crop" is used to denote luxuriant crops which grow rapidly and densely enough to completely shade, and partly exclude fresh air from, certain undesirable plants which may be growing on the same soil. The dense shade falling on the more slowly growing weeds prevents their manufacturing sugars and thus hinders their growth. Such crops as cowpeas, Rhodes grass, sweet clover, vetches, and alfalfa may be classed as smother crops. Alfalfa is the very best all round smother crop in California, though other plants can be successfully used on certain soils to control minor weeds.

For the general farmer, growing field crops such as grain, potatoes, and corn, one of the best methods of ridding fields of morning glory is smothering with alfalfa, provided irrigation is available. If the morning glory is vigorous and has practically over-run the field, that is good evidence of the fertility of the soil and its probable suitability for alfalfa. It must be understood that if the alfalfa is to choke

out or smother the weeds, the soil and moisture conditions must be such as to insure a fine, even stand of alfalfa within a short time after seeding and before growth of morning glory begins in the spring. The soil should be well prepared by deep plowing as early in the fall as possible; first, in order that the morning glory shall not go to seed; second, in order to insure a good seed bed and a greater penetration of rainfall; third, in order to be able to sow the alfalfa early, so that it may start before the morning glory roots, in the colder soil below, have sent up their new shoots. The deeper the plowing and the more thorough the work, the later the morning glory will come through. Deep cultivation before seeding will pull out and destroy most of the loosened roots. Sow the alfalfa seed shallow, eighteen pounds to the acre, with a drill, in February if possible. In those parts of California where temperatures do not go below 25° F., February is none too early. Seed sown then gives the best results. The maintenance of alfalfa on a field for two to three years often so weakens the morning glory that after a deep plowing, followed by a year of intensive cultivation, the weed is controlled. The Spreckels Sugar Company[1] found that the use of alfalfa was the best, most economical, and at the same time most profitable method of control where the soil was suitable for this crop. The method did not prove completely effective, as there was some morning glory on the land even after three years of alfalfa planting. But this was largely on account of the poor stand obtained and the slow rate of growth of alfalfa under the climatic conditions of the region.

SMOTHERING WITH NON-LIVING MATERIAL

In attempts to eradicate morning glory by smothering with organic matter, such material as eucalyptus leaves, beet pulp, manure, straw and tar paper have been tried and proved inadequate.

The Spreckels Sugar Company[1] have carried on extensive experiments in this line also. Tar paper was laid over morning glory patches, lapped four inches, and the laps covered with dirt. The plants had pushed through the laps by May and grew vigorously. Eucalyptus leaves piled on the soil six inches deep over morning glory were of no avail. Beet pulp piled on the ground fifteen inches deep was no better. When barnyard manure was piled on the weeds to a depth of six feet, the plants and flowers soon appeared on top of the heap. Straw has also proved inadequate.

PASTURING WITH HOGS AND SHEEP

Cox[2] in his bulletin on morning glory states that the roots taste like sweet potato (both plants belong to the same family, *Convolvulaceae*). There are two methods of pasturing fields badly infested with morning glory outlined by Cox.[2] One of these is to turn hogs into the field immediately after the crop is harvested and to allow them to root as best they may. They will eat some of the tops and dig out the more easily reached roots until in the course of three years or less the field may become a profitable crop-producing area again. Under the second plan the field should be first deeply plowed, preferably in the early spring. At frequent intervals during the summer, when convenient, the field should be replowed, exposing the roots so that the hogs may more easily reach them.

Cox[2] states that by this method the weed may be controlled in one year, unless the underground parts extend too deep to be reached by the hogs. As in California the roots always extend several feet below the surface, there is little hope of controlling the pest in this state by this means.

SALT BRINE METHOD

It has been a matter of common knowledge for many years that plants cannot endure large quantities of ordinary salt. If used in sufficient quantities it will kill morning glory plants. Salt in small amounts is not poisonous to man or animals; the material is easy to apply, easy to obtain, and is relatively cheap. On the other hand the use of salt on land *prevents the growth of all vegetation* for a number of years, varying according to the amount applied and the amount of leaching by rains or irrigation and the consequent drainage. If applied on large fields in large quantities the farmer will have to contend with an "alkali" problem instead of with the morning glory. In the eastern states as much as twenty tons of salt to the acre are often used for this purpose, but after one or two years the soil is back to normal again. In the West this would not be the case, for such an amount of salt would probably remain unchanged for many years. It has been said that the salt-treated areas in California, though completely rid of morning glory, are *not productive* and remain wet and boggy during the spring plowing season, thus hindering the work of tillage.

On land which is at present untilled and to which none of the above objections would apply, the salt brine method of control of

morning glory recommended by C. W. Beers[3] can be used with advantage. Along driveways, fence lines, and ditch banks it is especially useful. The preparation of the soil must be thorough; it should be spaded or plowed deep (eight to ten inches) some distance beyond the spread of morning glory, and finely pulverized in order to enable it to absorb the solution of salt quickly. Ordinary unrefined rock salt, dissolved at the rate of two pounds to a gallon of water, may be used. This solution should be poured on to the soil until it is thoroughly wet to a depth of eight or ten inches. A trial of ten gallons will determine the amount necessary to wet a given area of soil. The amount to be used will depend upon the nature of the soil and the amount of moisture present at the time of operation.

After the entire area is wet to the desired depth, it should be covered with at least one foot of straw, leaves, or other cheap litter, and wet down thoroughly. The straw will prevent baking, act as a mulch, and thus conserve the moisture. Frequent examination should be made from time to time to determine the amount of moisture present. Whenever water is needed, the mulch should be thoroughly wet down. Or, rock salt could be scattered on the soil at the rate of two or more tons per acre and wet down thoroughly. The success of this method is dependent upon the presence of sufficient moisture. This factor must not be overlooked.

As the final result of the treatment the plant is killed by an excess of salt. A period of at least two years must elapse before soil so treated can be utilized for crops. If leached by heavy irrigation or rains so that adequate drainage is afforded, the soil may perhaps be recovered eventually for agricultural purposes.

SODIUM ARSENITE AS A WEED KILLER

Among the principal chemicals utilized for the control of weeds are arsenic in the form of sodium arsenite, iron sulfate for broad leaved plants such as dandelions and mustard, and carbon bisulfid.

The railroads use, during the late growing season for plants on their right-of-ways, enormous quantities of sodium arsenite, which is purchased from the manufacturers in tank-car lots. Arsenic is a by-product of the smelting of ores in modern metallurgy, which after recovery as arsenic tri-oxide is made soluble by treatment with sodium hydroxide or carbonate. The result is sodium arsenite, a soluble plant and animal poison in concentrated form. This material may be dissolved as needed at the rate of only one pound of arsenic to twenty-five gallons of water. When sprayed on vegetation, except most

grasses, and especially on broad-leaved plants, the solution is absorbed by the leaves and stems. The result is the death of the plant if all the conditions are right. But just what these conditions are and whether the maturity of the plant, the time of day when the application is made, the amount of soil moisture present, or the amount of moisture present in the plant itself or in the atmosphere are factors of importance has so far not been fully determined. Until some fundamental research work on the problem has been done and the factors affecting toxicity of chemicals in relation to plant life are determined, the use of chemicals as weed killers is purely an empirical matter. Experiments so far completed point to the importance of all the above mentioned factors.

Arsenic, in the form of sodium arsenite, has been used by many investigators for the eradication of plant life. Krauss[6] has found this material very useful in the suppression of weed growth among pineapples in the Hawaiian Islands. A solution of one pound of arsenic to ten gallons of water applied as a spray between the rows proved satisfactory in controlling the weeds. The soils of the islands are rich in iron, and due to the consequent formation of insoluble arsenic-iron compounds the large quantities of arsenic annually applied do not interfere with regular crops grown on the soil.

Arsenite of soda in the form of a spray has been extensively used in Australia[7] for the control of prickly pear and other undesirable plants. Of late years, however, the usage has been largely discontinued. In the rubber plantations of Hawaii[8] sodium arsenite spray is now generally used as a means of controlling the rich plant undergrowth infesting the plantings of rubber trees. Extensive experiments on the control of morning glory with arsenical sprays were carried out at Berkeley, Davis and Spreckels (in conjunction with the Spreckels Sugar Company) and at Centerville, Alameda County, in 1915, 1916 and 1917 by George P. Gray, who was at that time chemist in charge of the Insecticide and Fungicide Laboratories at the University of California.

Gray[9] investigated the toxicity or killing power of sodium arsenite when applied either to the roots or to the tops of vines alone. The results obtained were so completely influenced by varying conditions of which little was known at that time that he could not predict the result of further applications. He found that the spray applied in a very dilute solution to the mature plants in the coast regions actually killed the roots of wild morning glory over the entire experimental plot to a depth of three to four feet. A few of these plants, however, revived the following spring or summer, although

many of them required a full year to reach the surface. As the evidence obtained from these experiments was considered worthy of publication, Station Circular No. 168[9] was printed recommending this treatment for morning glory in the fog-belt of California. After the publication of the circular further experiments were carried on at various places in the state during the succeeding fall. The results of these investigations, however, do not warrant the general use of this method except in the fog-belt.[12]

Investigators seem to agree on one condition only, which is that the plants must be mature, preferably in full bloom or in seed, for the spray to be effective on the roots. At present no recommendations can be made as to the time or method of application of sprays of sodium arsenite. The best dosage or the amount of arsenic to be used in the spray material has not been fully determined for all plants. The various railroads using this material for a general weed killer use different dilutions in different places.

The dangers associated with the use of soluble arsenic are many. Sodium arsenite is poisonous in very small doses. It is usually very caustic in the concentrated form, and will cause severe burning if brought into contact with the skin. It may kill trees and vines if it reaches them when the morning glory is being sprayed. Arsenic has proved very injurious to stock, which have a preference for eating plants sprayed with this poison. Very small quantities are sufficient to kill them. The fumes of burning arsenic are poisonous to man or animal. In burning plant growth that has been sprayed and killed with arsenic, care should be exercised to avoid breathing the smoke. *Arsenic fumes smell like garlic* and are thus easily detected.

COMMERCIAL WEED KILLERS

The market is flooded with the products of certain weed killer manufacturers who unhesitatingly state that their solutions will absolutely control almost any weed, fern, or grass. It has been determined and reported by the Division of Chemistry of the State Department of Agriculture at Sacramento[10] that all samples so far examined, with the exception of one which is carbon bisulfid, are simply solutions of sodium arsenite. Many of these arsenical herbicides (weed killers), Gray tells us,[10] are not labelled poisonous and may, for this reason, endanger the lives of both livestock and human beings. Some makers state that their product is not poisonous to land when applied as directed, but in point of fact a pint of the concentrated solution would sterilize a square yard of soil for many

years and absolutely prevent plant growth. (See fig. 11.) Gray[10] shows that the prices asked for most of these herbicides are beyond reason, and are proportionate only to the exorbitant claims made for them. Sodium arsenite, sold under that name, would find a ready market and might be recommended as an herbicide for sterilizing walks, drives, ditch banks and such places, when used by operators who know the poisonous nature of the material they are using. Some companies are now putting out sodium arsenite for this purpose.

Fig. 11.—Sterilizing effect of arsenic on soil when applied in heavy doses. Photo by G. P. Gray.

CARBON BISULFID FOR SMALL PATCHES

The treatment of morning glory with carbon bisulfid has been investigated by Thomas Mayhew, farm advisor of Monterey County, and the results of his investigations are found in his report on this work. The work has been carried on since the summer of 1919, and the investigation has been thorough. Carbon bisulfid is a *volatile, explosive liquid* and can be secured in the markets in any quantity. Mayhew has proved that morning glory may be eradicated by the use of this chemical. *The danger of fire and injury from this compound should be carefully guarded against.* Mayhew makes the following recommendations:

The work should be done while the soil is quite dry in order to permit the gas formed in the soil to spread as far as possible.

The liquid is to be applied by making holes three feet apart each way over the entire surface of the morning glory covered patch. These holes to be made with a bar to a depth of eighteen inches. Place four ounces of carbon bisulfid in each hole and fill with soil. The gas filters out through the dry soil and in some manner kills the weeds, for in one week the tops show the effects, and in one month the vines are dead.

The crop yield has been found to increase after using carbon bisulfid. This result is apparent the following year. There is no evidence as to how long the ill effects of the gas remain in the soil. This treatment is especially recommended for small isolated patches that are inconvenient for cultivation and for this reason would be neglected. The cost is almost prohibitive for large areas, although it has proved to be satisfactory in killing morning glory.

The use of carbon bisulfid for eradication of morning glory in orchards or vineyards cannot be recommended. The danger of killing trees or vines is too great.

In the preparation of land for grape vines in August, 1921, County Farm Advisor Harrison of Yuba County recommended carbon bisulfid for eradication of isolated patches of morning glory before planting. Thereafter a certain fruit grower who was subsoiling forty acres of hard pan soil preparatory to planting vines conceived the device of attaching a container for carbon bisulfid with an outlet pipe and stop cock to the subsoiler, seating an attendant on the machine to open the stop cock while passing through the morning glory patches in order to allow the solution to flow into the soil directly at the bottom of the furrow. About fifty gallons of carbon bisulfid altogether were used in this experiment and the method proved entirely satisfactory, only a few plants appearing the following spring. These were easily hoed out and completely eradicated.

PREVENTION

Knowing as we do the extent of the country infested with this weed, it is advisable to use all the precautions possible to prevent new infestations. First of all, the matter of using seeds free from morning glory is of vital importance. All morning glory seeds should be removed from grains used for seed purposes, especially those to be sown on clean land. All barnyard manure should be composted before spreading, in case hay or grain containing morning glory seeds is fed to the stock.

All small infestations or patches of morning glory should be carefully dug out and the roots and tap roots burned or thoroughly dried out. The soil should be piled up in a mound one foot or more high over such treated patches, and the process repeated if the growth

reappears. Carbon bisulfid or salt treatment has proved useful under certain conditions, as shown by this circular. Larger patches of the weed can be handled by the "cutting" method. (See fig. 12.) Plows and cultivators when moved from place to place and from infested to clean fields should be carefully examined and all traces of morning glory removed in order to prevent the infestation of new fields.

Fig. 12.—An efficient 4-horse weeder used for many years in morning glory control. This three-blade type is best adapted to rough land.

SUMMARY

1. Morning glory or bindweed is called botanically *Convolvulus arvensis* Linnaeus. It is a perennial of great economic importance.

2. It is found throughout California and is well distributed over the United States.

3. The persistent growth of this plant after repeated cuttings is due to the large amount of plant food stored in the roots. This food must be exhausted in order to kill the plant.

4. Cultivation (cutting below the surface), if thorough and frequently enough employed during one growing season, will kill the plant in one year. The interval between cuttings should generally not be greater than five days. *Never allow green leaves to appear!*

5. Alfalfa may kill out morning glory in two to three years. A good stand is necessary. Alfalfa yields profitable crops at the same time.

6. Covering morning glory with straw or other dead material will not check its growth.

7. Hogs may in California, in certain instances, kill out morning glory by eating its roots. This method is used extensively in the eastern states. Sheep aid in the work by grazing on the green parts of the plant.

8. Salt brine will kill morning glory. It is recommended for soil not used for crop purposes.

9. Sodium arsenite is toxic to plants. It is used in many places as an herbicide. Recommendation of its general use on morning glory is not justified by the investigations made.

10. Commercial weed-killers, largely solutions of sodium arsenite, are too expensive and cannot be recommended for the reason that no one knows just when to apply them.

11. For small patches of morning glory carbon bisulfid is *very satisfactory.*

12. The eradication of small colonies at the beginning will save a great deal of expense later on.

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